

**PRELIMINARY
LICHEN BIOMONITORING PROGRAM
AND AIR QUALITY BASELINE**

**IN SELECTED CLASS I WILDERNESS AREAS
OF CORONADO, COCONINO, KAIBAB, PRESCOTT AND TONTO
NATIONAL FORESTS, ARIZONA**

C O P Y

FINAL REPORT

MAZATZAL WILDERNESS AREA

Arizona, Gila County
Tonto National Forest
Mazatzal Wilderness Area

SUBMITTED BY

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INTRODUCTION

Project objectives:

1. Collect, curate, and identify lichen species from selected sites in the Sycamore Canyon, Pine Mountain, Mazatzal, Sierra Ancha, Superstition, Galiuro and Chiricahua wilderness areas.
2. Identify potential sites in each wilderness area for establishing lichen monitoring transects and plots.
3. Identify and collect pollution-sensitive lichen species for elemental analyses from 5-7 reference sites in each wilderness area. Rare species will not be sampled for analysis, but their distribution will be noted.
4. Determine baseline thallus concentrations of sulfur, lead, and copper, using ten replicate samples of one documented pollution-sensitive species from each wilderness area.
5. Prepare and submit a draft report by 28 December 1990.
6. Prepare and submit 3 copies of a final report detailing the results of this study by 11 July 1991. This final report will include:
 - a. a map and a brief habitat description of the study sites in each wilderness area, and reasons for their selection.
 - b. a preliminary list of lichen species for each wilderness area with relative abundance and substrate data for each species.
 - c. a list of pollution-sensitive or potentially pollution-sensitive lichen species for each wilderness area.
 - d. color photographs/slides of lichens known or suspected to be sensitive to specified air pollutants for each wilderness area.
 - e. baseline concentrations of lead, sulfur, and copper for one indicator species from each wilderness area.
 - f. a map of recommended sites for establishing transects and plots for future long-term monitoring.
 - g. a list of references, protocols, equipment and supplies used in this study.
 - h. other pertinent information or unusual observations.

Lichens as sensitive receptors:

The use of lichens as bioindicators of air quality is a well-documented procedure (Ske 1979; Richardson & Nieboer 1981; Fields & St. Clair 1984; St. Clair 1989; Rope & Pearson 1990). Hale (1983) noted that lichens have been used in three ways to monitor the effects of air pollution on biological systems: 1) elemental analysis of lichen tissues, 2) mapping of all

(or selected) lichen species found in areas adjacent to pollution sources, and 3) transplant studies. Currently, the most common approach involves a floristic survey and elemental analysis of tissues from selected indicator species (St. Clair 1989; Wetmore 1981, 1989).

Because lichens accumulate many different pollutants from atmospheric outwash, lichen tissues (or thalli) provide a record of the kinds and relative quantities of pollutants in any particular airshed (Gough & Erdman 1977; Schutte 1977; Wetmore 1989; Rope & Pearson 1990). Pollution patterns for specific elements can be monitored over time by determining thallus growth rates and elemental concentrations in excised portions of the thallus (Lawrey & Hale 1981). Lichen physiological processes indicate pollution-related damage long before other, more visible changes in color, morphology, or community structure can be detected or even monitored (Sundstrom and Hallgren 1973; Fields and St. Clair 1984).

Lists of pollution-sensitive lichen species have commonly been published in conjunction with floristic and ecological surveys (Wetmore 1981, 1989; Rushforth et al. 1982). As certain lichen species form particular substrates are inherently more sensitive to airborne contaminants, air quality can be effectively monitored by occasionally reevaluating lichen community and/or physiological parameters. Pollution-related changes can then be documented by comparing follow-up data to the original baseline data.

General habitat description for Arizona:

The state of Arizona includes several of North America's major biotic provinces: Sonoran, Chihuahuan, Mojave, Great Basin, and Colorado Plateau deserts; Rocky Mountain, Sierra Madrean, encinal, and pinyon-juniper woodlands; and inland chaparral. Elevation ranges from less than one hundred feet above sea level in Yuma County to over twelve thousand feet in Coconino County. Precipitation varies, but almost all portions of the state are watered to some extent by winter rain or snow and summer monsoons, with occasional chubascos in early fall. The Mogollon Escarpment divides Arizona's two major geologic provinces: the Basin and Range Province to the south and west, and the Colorado Plateau to the north and east. This project has involved a preliminary survey of seven of the eight Class I Wilderness areas in Arizona (figure 1).

General description of the Arizona lichen flora:

With over 600 species reported, Arizona's rich lichen flora results from the state's habitat diversity. The forests of the White Mountains, the Mogollon Escarpment, the Chiricahuas, and other high elevations throughout the state, also the encinal of Cochise and eastern Pima counties, support a rich epiphytic lichen flora. Crustose forms predominate on igneous substrates of the southern deserts and sedimentary rocks of the Colorado Plateau.

Bibliography of lichen studies in Arizona:

- Darrow, R. A. 1950. The arboreal lichen flora of southeastern Arizona. Am. Midl. Nat. 42:484-502.

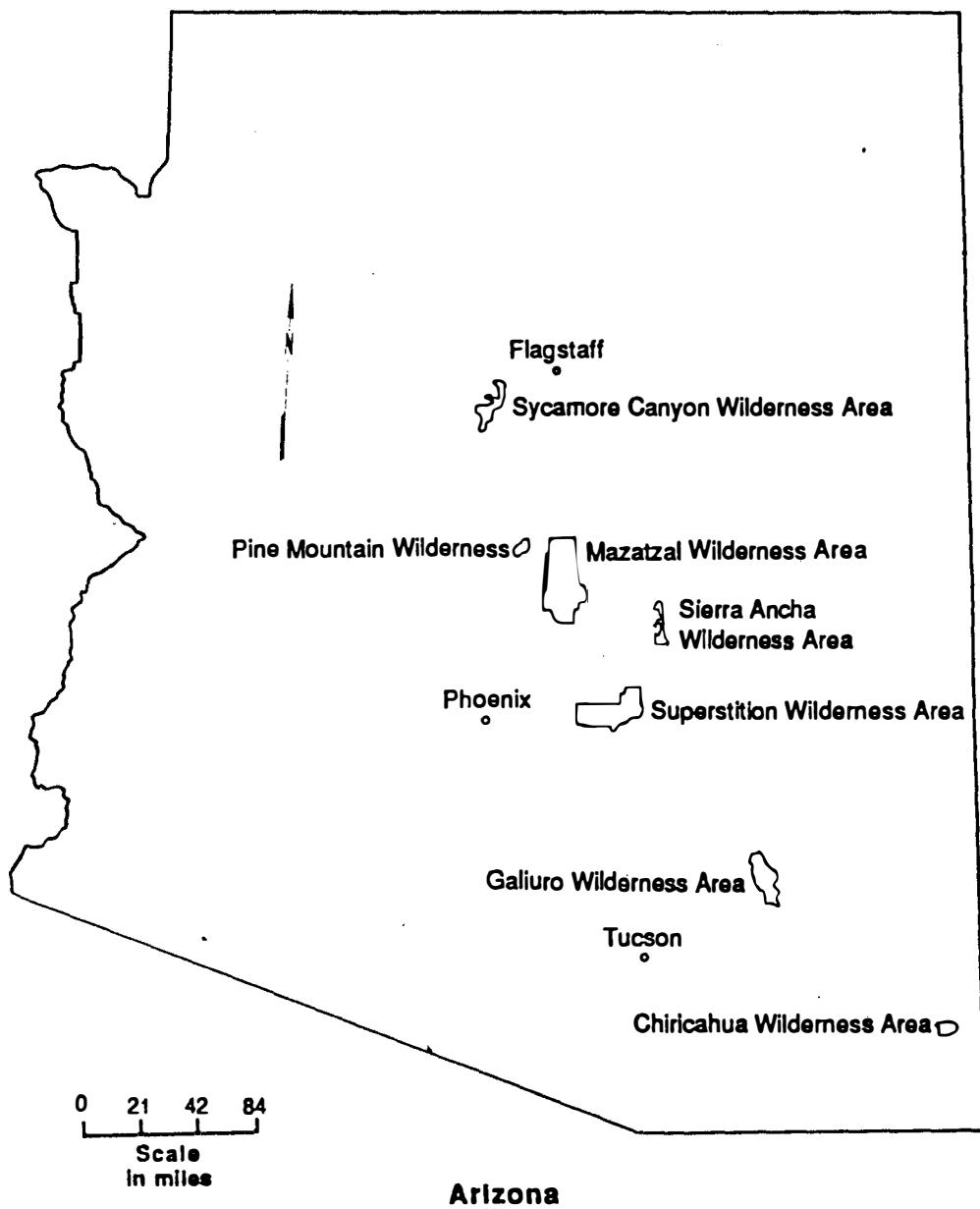


Figure 1

- Flowers, S. 1963. The lichen and moss flora of Betatakin Canyon and vicinity, Navajo National Monument, Arizona. Univ. Utah Div. Biol. Sci. Misc. Pap. 10pp.
- Johnsen, A. B. 1965. Some Lichens from West Fork, Coconino County, Arizona. *The Bryologist* 68: 241-243.
- Nash, T. H. 1973. Additions to the lichen flora of Arizona I. *The Bryologist* 76: 545-547.
- 1974. Lichens of the Page environs as potential indicators of air pollution. *Journ. Ariz. Acad. Sci.* 9:97-101.
- 1975. Lichens of Maricopa County, Arizona. *Journ. Ariz. Acad. Sci.* 10: 119-125.
- 1976. Lichens of the White Mountains, Arizona. *Journ. Ariz. Acad. Sci.* 12: 53-56.
- 1985. Additions to the lichen flora of Arizona III. *The Bryologist* 88(1): 19-22.
- & A. B. Johnsen. 1975. Catalog of the lichens of Arizona. *The Bryologist* 77: 472-474.
- & W. Weber. 1974. Additions to the lichen flora of Arizona II. *The Bryologist* 77: 472-474.
- Nebeker, G. T. & L. L. St. Clair. 1984. The lichen flora of Navajo National Monument, Arizona. *Mycotaxon* 19: 413-422.
- Rudolph, E. D. 1953. A contribution to the lichen flora of Arizona and New Mexico. *Ann. Mo. Bot. Gard.* 40: 63-72.
- Weber, W. A. 1963. Lichens of the Chiricahua Mountains, Arizona. *Univ. Colo. Stud. Ser. Biol.* 10: 1-27.

General habitat description for the Mazatzal Wilderness Area:

The Mazatzal Mountains are a late Laramide complex of Precambrian granite and metasedimentary rocks overlain by Cenozoic rhyolite, tuff and other extrusives. Topography throughout this area is extremely rugged, the landscape variously dissected, the elevation ranging from 2600 ft. near Bartlett Reservoir to 7903 ft. at Mazatzal Peak. Sonoran desert vegetation predominates in the lower elevations of the wilderness area, with semidesert

grasslands, inland chaparral, and mixed conifers occurring sequentially in higher slopes.

The Phoenix metropolitan area and the Globe copper smelter are likely the two most significant sources of pollution in this area.

METHODS

Procedures for selecting reference sites:

Specific locations for specimen collection (reference sites) in the wilderness were determined in consultation with Forest Service personnel. Sites were selected for accessibility, substrate diversity and habitat diversity. Specifically, occurrence of unusual geologic substrates, vascular plant communities, soil types, mesic canyons, and spring or wet wall areas were given particular consideration. Baseline data from the reference sites (species diversity, relative abundance, and elemental analysis data for indicator species) forms the foundation for evaluating future air pollution-related changes in lichen communities.

Collection, preparation and identification of lichen specimens:

Because lichen distribution is directly influenced by substrate, moisture, and sunlight, all available substrates and habitats around each reference site were carefully examined. Small amounts of each lichen species was removed directly from the substrate where possible, or, depending on the species, with small pieces of bark, soil or rock.

Specimens were put in carefully labeled paper sacks and taken to the BYU Herbarium of Nonvascular Cryptogams, where they were washed, curated, and placed in permanent herbarium packets labeled with collection site, habitat and substrate information. Species were identified using standard lichen keys and taxonomic treatises. Where appropriate standard chemical and thin-layer chromatography techniques were used to finalize species identifications. A permanent collection of the lichen species from each reference site has been prepared and will be maintained in the BYU Herbarium of Nonvascular Cryptogams. As requested by the Forest Service a set of duplicate specimens will be sent to the Lichen Herbarium at Arizona State University.

Collection of lichen thalli for laboratory analyses:

After careful consideration of species abundance, substrate, growth form, documented/suspected pollution sensitivity, and distribution patterns of the lichens at each reference site, 3-5 taxa were designated as indicator species for all laboratory chemical analyses.

At all reference sites sufficient material (10-15 grams) of each indicator species was collected for laboratory analyses. This material was stored in Hubco cloth bags to prevent sulfur contamination. One or two indicator species from one reference site was analyzed for sulfur, lead and copper, some of the most common air pollutants in the general vicinity of the

wilderness area. Analysis for these pollutants was determined in consultation with Forest Service personnel. Excess material for all indicator species is currently stored in Hubco cloth bags at the Herbarium of nonvascular cryptogams at Brigham Young University.

Determination of elemental concentrations in lichen tissues:

In the laboratory, all surface debris was carefully removed from elemental analysis samples. Samples were then oven dried and ground to powder. Ten 500 mg replicates of one - two indicator species from one reference site in the wilderness were then analyzed for sulfur, lead and copper. Following digestion of samples with nitric and perchloric acid, lead and copper content was assessed using atomic absorption spectrophotometry. Sulfur was subsequently analyzed turbidimetrically using Barium chloride ($BaCl_2$). All analyses were performed by the Brigham Young University Plant and Soil Analysis Laboratory.

RESULTS AND RECOMMENDATIONS

Habitat information and specific location for each reference site:

In Mazatzal Wilderness Area lichens were collected from Hardscrabble Canyon west of Strawberry, AZ, and Barnhardt Trail west of Rye, AZ. In December 1990 additional collections were made along Sheep Bridge Trail east of Horseshoe Reservoir. Hardscrabble Canyon, at an elevation of 1460 msm (4800 ft.), is characterized by chaparral, pinyon pines, and alligator junipers; lithology and soils are primarily basaltic. Barnhardt Trail at 1220 msm (4000 ft.), is similar but richer in Sonoran Desert elements such as beargrass, agave, yucca, and various cacti, with a lithology of Tertiary sedimentary and Precambrian metasedimentary rock. Sheep Bridge Trail starts at 633 msm (2080 ft.) and winds through chalky hills characterized by Sonoran Desert elements such as *Carnegiea gigantea*, *Larrea tridentata*, *Ziziphus obtusifolia* and *Canotia holacantha*. Figure 2 details collections sites for the Mazatzal Wilderness Area.

Preliminary observations and recommendations:

1. Mazatzal Wilderness Area has a well developed aridland lichen flora. A total of 72 species in 35 genera were identified from this wilderness area (see "Checklist of Lichen Species Mazatzal Wilderness Area, Arizona" for details). This list represents approximately 50 - 60% of the total lichen flora for this wilderness area. All growth forms are represented in the flora. Specifically, the flora is dominated by foliose species (49% or 35 species) followed by crustose species (38% or 27 species), squamulose species (10% or 7 species), fruticose species (1% or 1 species) and umbilicate species (1% or 1 species). Rock lichens dominate the flora (51%) followed by bark lichens (36%) and soil lichens (14%).
2. Crustose saxicolous lichens were richer in Hardscrabble Canyon than corticolous forms, and terricolous forms were rare. Scarcity of terricolous forms on the mesa is probably related to livestock grazing, and scarcity of terricolous forms in the canyon

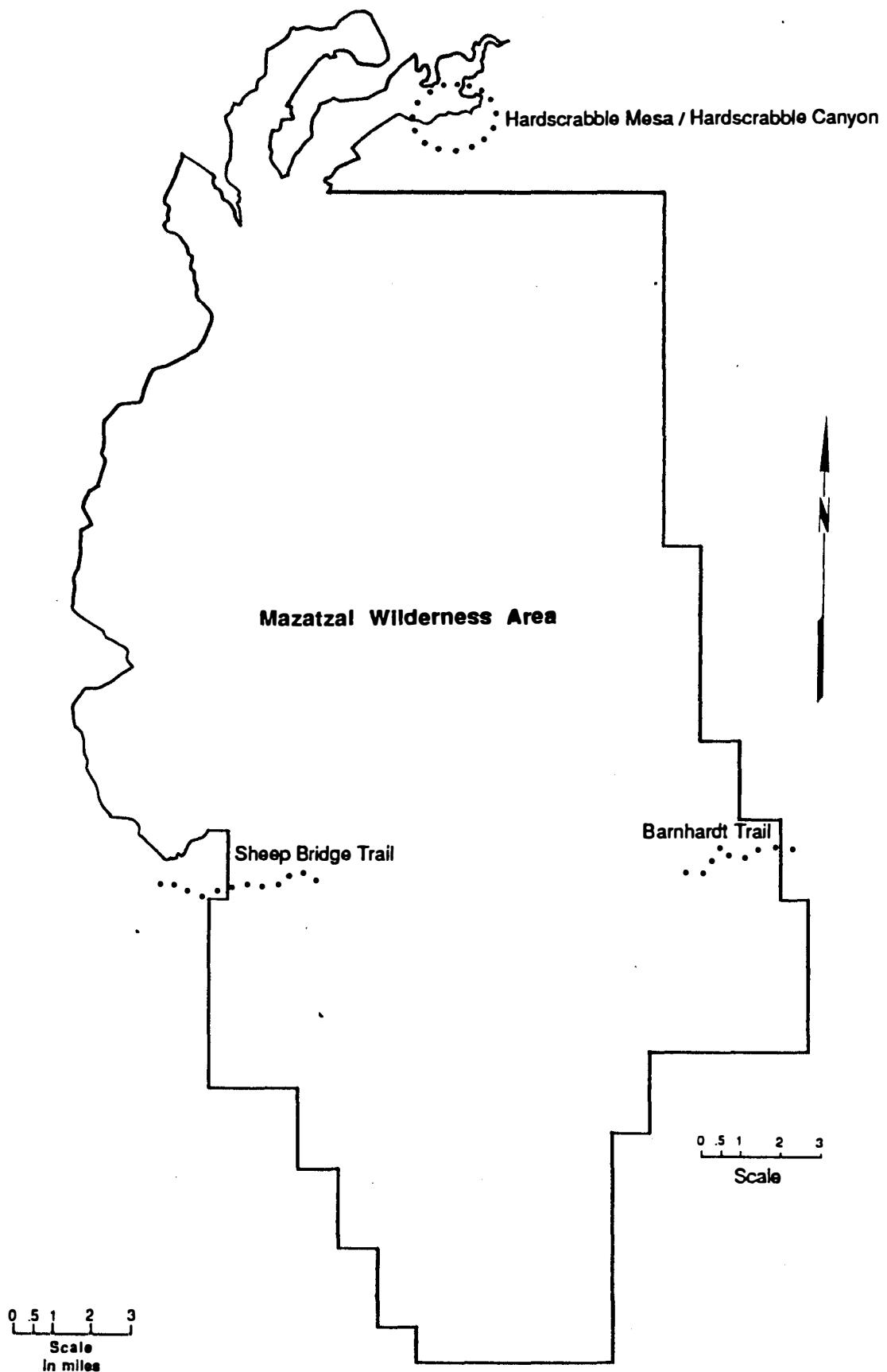


Figure 2

- to lack of stable soils on steep slopes.
- 3. Saxicolous, corticolous and terricolous lichen floras along Barnhardt Trail were altogether richer than those in Hardscrabble Canyon.
- 4. Pollution-related thallus damage was not visually apparent in samples collected so far.
- 5. Table 2 contains a list of several lichen species which have been shown to be sensitive to various air pollutants. Photographs of some of these species are included with this report.
- 6. Elemental analysis data for *Xanthoparmelia cumberlandia* show elevated levels of sulfur (.227%) suggesting the need for an ongoing biomonitoring program for sulfur dioxide accumulation in the wilderness area. However lead and copper levels are well within the normal (low-impact) range (Table 3).
- 7. Elevated sulfur concentrations in *Xanthoparmelia cumberlandia* and proximity of this class I airshed to metropolitan Phoenix suggests the need for establishing a comprehensive lichen biomonitoring program for this wilderness area.
- 8. A list of all lichen species collected from all wilderness areas during the course of this study is included for your information (Table 1).

Format of general species list for the Mazatzal Wilderness Area:

The following data are recorded for each species in the general species list (all species are listed alphabetically by genus):

- 1. current epithet (genus & species) with authors, nomenclature generally follows Egan (1987, 1989, 1990)
- 2. lichen growth form (ie fruticose, foliose, crustose, squamulose, umbilicate)
- 3. substrates (ie rock, soil, bark, decorticated wood)
- 4. specific collection site(s)
- 5. relative abundance (ie rare, locally common, common, abundant)
- 6. documented pollution sensitivity with appropriate literature citation(s) (ie sensitive, intermediate, tolerant)
- 7. general comments (including occurrence on atypical substrates, unusual morphology, new species records for Arizona, descriptive information for unidentified specimens.
- 8. deposition of specimens (ie BYU Herbarium with duplicates to ASU)

**CHECKLIST OF LICHEN SPECIES
MAZATZAL WILDERNESS AREA, ARIZONA**

Acarospora cinereoalba (Fink) Magnusson

Growth form: crustose
Substrate: on rocks (basalt)
Site(s): Sheep Bridge Trail
Relative abundance: rare - locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14997

Acarospora cf. cervina var. **glaucocarpa** (Wahlenb. in Ach.) Korber

Growth form: crustose
Substrate: on rocks (sandstone)
Site(s): Sheep Bridge Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14996

Aspicilia alphoplaca (Wahlenb. in Ach.) Poelt & Leuck.

Growth form: crustose with lobed margins
Substrate: on rocks
Site(s): Sheep Bridge Trail
Relative abundance: locally common
Pollution sensitivity: sensitive to sulfur dioxide (Marsh and Nash, 1979)
Comments: none
Deposition of specimens: BYU Herbarium #15001

Aspicilia calcarea (L.) Mudd

Growth form: crustose
Substrate: on rocks (basalt)
Site(s): Hardscrabble Canyon
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15002 (duplicate specimen sent to ASU)

Aspicilia cinerea (L.) Korber

Growth form: crustose
Substrate: on rocks
Site(s): Hardscrabble Canyon
Relative abundance: rare - locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14999

Aspicilia desertorum (Krempelh.) Mereschk. (Weber 1981)

Growth form: crustose

Substrate: on rocks

Site(s): Sheep Bridge Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15000

Aspicilia quartzitica W. Weber (Weber 1971)

Growth form: crustose

Substrate: on rocks (basalt)

Site(s): Hardscrabble Canyon

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14995

Buellia retrovertens Tuck.

Growth form: crustose

Substrate: on rocks

Site(s): Sheep Bridge Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15030

Caloplaca arizonica Magnusson

Growth form: crustose

Substrate: on juniper bark, oak bark, live oak bark

Site(s): Hardscrabble Canyon, Hardscrabble Mesa

Relative abundance: locally common - common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15031 (duplicate specimen sent to ASU),
15032, 15033

Caloplaca chrysophthalma Degel.

Growth form: crustose

Substrate: on mesquite bark

Site(s): Sheep Bridge Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15034 (duplicate specimen sent to ASU)

Caloplaca cinnabrina (Ach.) Zahlbr.

Growth form: crustose
Substrate: on rocks (basalt)
Site(s): Sheep Bridge Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15037

Caloplaca durietzii Magnusson

Growth form: crustose
Substrate: on juniper decorticated wood, pine bark
Site(s): Hardscrabble Mesa
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15035 (duplicate specimen sent to ASU),
15038

Caloplaca flavovirescens (Wulfen) Dalla Torre & Sarnth.

Growth form: crustose
Substrate: on rocks (basalt)
Site(s): Hardscrabble Canyon
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15039

Caloplaca pelodella (Nyl.) Hasse

Growth form: crustose
Substrate: on rocks (basalt)
Site(s): Sheep Bridge Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15036

Candelaria concolor (Dickson) B. Stein

Growth form: minutely foliose
Substrate: on Gambel oak bark
Site(s): Hardscrabble Canyon
Relative abundance: rare
Pollution sensitivity: sensitive - intermediate (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #15040

Candelaria concolor var. *effusa* (Tuck.) Burnham

Growth form: minutely foliose
Substrate: on Alligator juniper bark
Site(s): Hardscrabble Canyon
Relative abundance: rare
Pollution sensitivity: sensitive - intermediate (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #15041

Candelariella xanthostigma (Ach.) Lettau

Growth form: minutely foliose
Substrate: on lignum (Alligator juniper)
Site(s): Hardscrabble mesa
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15042

Catapyrenium lachneum (Ach.) R. Sant.

Growth form: squamulose
Substrate: on rock (basalt), soil
Site(s): Sheep Bridge Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15043 (duplicate specimen sent to ASU),
15044 (duplicate specimen sent to ASU)

Cladonia pyxidata (L.) Hoffm.

Growth form: squamulose with podetia
Substrate: on soil
Site(s): Barnhardt Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15045 (duplicate specimen sent to ASU)

Collema furfuraceum (Arnold) Du Rietz

Growth form: foliose
Substrate: on Gambel oak, rocks
Site(s): Hardscrabble Canyon, Barnhardt Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15046 (duplicate specimen sent to ASU),
15047

Collema fuscovirens (With.) Laundon

Growth form: foliose

Substrate: on rocks

Site(s): Hardscrabble Canyon, Barnhardt Trail

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15048, 15049

Collema polycarpon Hoffm.

Growth form: foliose

Substrate: on rocks (basalt)

Site(s): Hardscrabble Canyon

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15050 (duplicate specimen sent to ASU)

Dermatocarpon intestiniforme (Korber) Hasse

Growth form: foliose

Substrate: on rocks (basalt)

Site(s): Hardscrabble Canyon

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15051 (duplicate specimen sent to ASU)

Dermatocarpon miniatum (L.) Mann

Growth form: foliose (umbilicate)

Substrate: on rocks (basalt)

Site(s): Hardscrabble Canyon

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15052 (duplicate specimen sent to ASU)

Dermatocarpon reticulatum Magnusson

Growth form: foliose

Substrate: on rocks (basalt)

Site(s): Hardscrabble Canyon

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15053 (duplicate specimen sent to ASU),

15054

Diploschistes diacapsis (Ach.) Lumbsch

Growth form: crustose

Substrate: on rocks

Site(s): Barnhardt Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15055 (duplicate specimen sent to ASU)

Diploschistes muscorum (Scop.) R. Sant.

Growth form: crustose

Substrate: over bryophytes

Site(s): Barnhardt Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15056

Endocarpon pusillum Hedwig

Growth form: crustose

Substrate: on soil

Site(s): Sheep Bridge Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15057

Flavopunctelia flaventior (Stirton) Hale

Growth form: foliose

Substrate: on decorticated wood, live oak bark, pine bark

Site(s): Hardscrabble Canyon, Hardscrabble Mesa

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15058, 15059, 15060

Flavopunctelia soredica (Nyl.) Hale

Growth form: foliose

Substrate: on pine bark

Site(s): Hardscrabble Canyon

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15061 (duplicate specimen sent to ASU)

Hyperphyscia adglutinata (Florke) Mayrh. & Poelt

Growth form: foliose

Substrate: on zizyphus bark, mesquite bark

Site(s): Sheep Bridge Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15003, 15007

Lecanora argentata (Ach.) Malme

Growth form: crustose

Substrate: on pine bark

Site(s): Hardscrabble Canyon

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15062 (duplicate specimen sent to ASU)

Lecanora muralis (Schreber) Rabenh.

Growth form: crustose with lobed margins

Substrate: on rocks

Site(s): Sheep Bridge Trail

Relative abundance: locally common

Pollution sensitivity: tolerant (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #15063, 15064

Lecanora thallophila Magnusson

Growth form: crustose (obsolete)

Substrate: epiphytic on Dermatocarpon

Site(s): Hardscrabble Canyon

Relative abundance: rare

Pollution sensitivity: unknown

Comments: this species is a new record for Arizona

Deposition of specimens: BYU Herbarium #15065 (duplicate specimen sent to ASU)

Lecanora valesiaca (Mull. Arg.) Stizenb.

Growth form: crustose with lobed margins

Substrate: on rocks (basalt)

Site(s): Sheep Bridge Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15066

Lecidea tessellata Florke

Growth form: crustose

Substrate: on rocks

Site(s): Hardscrabble Canyon

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15067 (duplicate specimen sent to ASU)

Lecidella euphorea (Florke) Hertel

Growth form: crustose

Substrate: on pine bark, juniper lignum

Site(s): Hardscrabble Canyon

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15068, 15069

Leptogium arsenei Sierk

Growth form: foliose

Substrate: on Gambel oak bark

Site(s): Hardscrabble Canyon

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15070

Leptogium cynescens (Rabenh.) Korber

Growth form: foliose

Substrate: on rocks

Site(s): Barnhardt Trail, Hardscrabble Canyon

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15071, 15072

Leptogium furfuraceum (Harm.) Sierk

Growth form: foliose

Substrate: on live oak bark

Site(s): Hardscrabble Canyon

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15073

Leptogium lichenoides (L.) Zahlbr.

Growth form: foliose
Substrate: on rocks (basalt)
Site(s): Hardscrabble Canyon
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none

Deposition of specimens: BYU Herbarium #15074 (duplicate specimen sent to ASU)

Melanelia olivaceoides (Krog) Essl.

Growth form: foliose
Substrate: on live oak bark, pine bark
Site(s): Hardscrabble Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none

Deposition of specimens: BYU Herbarium #15075, 15076

Melanelia subolivacea (Nyl. *in* Hasse) Essl.

Growth form: foliose
Substrate: on pine bark
Site(s): Hardscrabble Canyon
Relative abundance: rare - locally common
Pollution sensitivity: unknown
Comments: none

Deposition of specimens: BYU Herbarium #15077

Neofuscelia infrapallida (Essl.) Essl.

Growth form: foliose
Substrate: on rocks (basalt)
Site(s): Hardscrabble Canyon
Relative abundance: rare - locally common
Pollution sensitivity: unknown
Comments: none

Deposition of specimens: BYU Herbarium #155078

Pannaria leucophaea (Vahl) P. Jorg.

Growth form: squamulose
Substrate: on rocks
Site(s): Barnhardt Trail
Relative abundance: rare - locally common
Pollution sensitivity: unknown
Comments: none

Deposition of specimens: BYU Herbarium #15079 (duplicate specimen sent to ASU)

Parmotrema hababianum (Gyelnik) Hale

Growth form: foliose
Substrate: on rocks
Site(s): Barnhardt Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15013 (duplicate specimen sent to ASU)

Peltigera canina (L.) Willd.

Growth form: foliose
Substrate: on soil
Site(s): Barnhardt Trail
Relative abundance: locally common
Pollution sensitivity: probably tolerant (Hale, 1982)
Comments: none
Deposition of specimens: BYU Herbarium #15080 (duplicate specimen sent to ASU)

Peltigera membranacea (Ach.) Nyl.

Growth form: foliose
Substrate: on soil
Site(s): Barnhardt Trail
Relative abundance: rare - locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15081

Pertusaria saximontana Wetm.

Growth form: crustose
Substrate: on juniper decorticated wood
Site(s): Hardscrabble Mesa
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14998 (duplicate specimen sent to ASU)

Phaeophyscia cernohorskyni (Nadv.) Essl.

Growth form: foliose
Substrate: on mesquite bark, juniper bark
Site(s): Sheep Bridge Trail, Hardscrabble Canyon
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15006, 15017 (duplicate specimen sent to ASU)

Physcia aipolia (Ehrh. ex. Humb.) Furnr.

Growth form: foliose

Substrate: on oak bark, live oak bark

Site(s): Hardscrabble Canyon

Relative abundance: rare - locally common

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #15014 (duplicate specimen sent to ASU),
15021

Physcia caesia (Hoffm.) Furnr.

Growth form: foliose

Substrate: on rocks

Site(s): Hardscrabble Canyon

Relative abundance: rare

Pollution sensitivity: intermediate (DeWit, 1976)

Comments: none

Deposition of specimens: BYU Herbarium #15012

Physcia dubia (Hoffm.) Lettau

Growth form: foliose

Substrate: on pine bark, juniper wood

Site(s): Hardscrabble Canyon

Relative abundance: rare - locally common

Pollution sensitivity: tolerant (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #15004, 15005 (duplicate specimen sent to
ASU)

Physcia stellaris (L.) Nyl.

Growth form: foliose

Substrate: on pine bark, oak bark, juniper bark, live oak bark

Site(s): Hardscrabble Canyon, Hardscrabble Mesa

Relative abundance: rare - locally common

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #15008 (duplicate specimen sent to ASU),
15015, 15018 (duplicate specimen sent to ASU), 15020 (duplicate specimen
sent to ASU), 15022

Physconia detersa (Nyl.) Poelt

Growth form: foliose

Substrate: on pine bark, live oak bark

Site(s): Hardscrabble Canyon

Relative abundance: rare - locally common

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #15009 (duplicate specimen sent to ASU),
15019 (duplicate specimen sent to ASU)

Physconia enteroxantha (Nyl.) Poelt

Growth form: foliose

Substrate: on pine bark, oak bark, rocks (basalt)

Site(s): Hardscrabble Canyon, Barnhardt Trail

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15010, 15016, 15023 (duplicate specimen
sent to ASU), 15024 (duplicate specimen sent to ASU)

Physconia perisidosa (Erichsen) Moberg

Growth form: foliose

Substrate: on rocks

Site(s): Barnhardt Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15011 (duplicate specimen sent to ASU)

Psora decipiens (Hedwig) Hoffm.

Growth form: squamulose

Substrate: on soil

Site(s): Hardscrabble Canyon

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15082 (duplicate specimen sent to ASU)

Psora himalayana (Church. Bab.) Timdal (Timdal 1986)

Growth form: squamulose

Substrate: soil over rocks (basalt)

Site(s): Hardscrabble Canyon

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15083

Psora luridella (Tuck.) Fink

Growth form: squamulose
Substrate: soil over rocks (basalt)
Site(s): Hardscrabble Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none

Deposition of specimens: BYU Herbarium #15084 (duplicate specimen sent to ASU)

Psora pseudorussellii Timdal (Timdal 1986)

Growth form: squamulose
Substrate: soil over rocks (basalt)
Site(s): Sheep Bridge Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none

Deposition of specimens: BYU Herbarium #15085

Psora tuckermanii R. Anderson ex Timdal

Growth form: squamulose
Substrate: soil over rocks (basalt)
Site(s): Hardscrabble Canyon
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none

Deposition of specimens: BYU Herbarium #15086 (duplicate specimen sent to ASU)

Punctelia hypoleucites (Nyl.) Krog

Growth form: foliose
Substrate: on rocks (basalt), pine bark, rocks
Site(s): Hardscrabble Canyon, Barnhardt Trail
Relative abundance: rare - locally common
Pollution sensitivity: unknown
Comments: none

Deposition of specimens: BYU Herbarium #15087, 15088, 15089 (duplicate specimen sent to ASU)

Rhizocarpon disporum (Naeg. ex Hepp) Mull. Arg.

Growth form: crustose
Substrate: on rocks
Site(s): Hardscrabble Canyon
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none

Deposition of specimens: BYU Herbarium #15090

Rhizocarpon geographicum Korber

Growth form: crustose
Substrate: on rocks
Site(s): Hardscrabble Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15091

Rinodina pachysperma Magn.

Growth form: crustose
Substrate: on juniper decorticated wood, pine bark
Site(s): Hardscrabble Canyon, Hardscrabble Mesa
Relative abundance: rare - locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15092 (duplicate specimen sent to ASU),
15093

Usnea hirta (L.) Weber ex Wigg.

Growth form: fruticose
Substrate: on pine bark
Site(s): Hardscrabble Canyon
Relative abundance: rare - locally common
Pollution sensitivity: sensitive - intermediate (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #15025

Xanthoparmelia coloradoensis (Gyelnik) Hale

Growth form: foliose
Substrate: on rocks
Site(s): Sheep Bridge Trail, Barnhardt Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15026, 15028 (duplicate specimen sent to ASU)

Xanthoparmelia cumberlandia (Gyelnik) Hale

Growth form: foliose
Substrate: on rocks
Site(s): Sheep Bridge Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #15029 (duplicate specimen sent to ASU)

Xanthoparmelia subramigera (Gyelnik) Hale

Growth form: foliose

Substrate: on rocks

Site(s): Sheep Bridge Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #15027 (duplicate specimen sent to ASU)

Xanthoria elegans (Link) Th. Fr.

Growth form: crustose with lobed margins

Substrate: on rocks (basalt)

Site(s): Sheep Bridge Trail, Hardscrabble Canyon

Relative abundance: locally common

Pollution sensitivity: sensitive (Hale, 1981)

Comments: none

Deposition of specimens: BYU Herbarium #15094, 15095

Xanthoria fallax (Hepp. in Arnold) Arnold

Growth form: minutely foliose

Substrate: on zizyphus bark, creosote bark

Site(s): Sheep Bridge Trail

Relative abundance: rare - locally common

Pollution sensitivity: sensitive - intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #15096, 15097 (duplicate specimen sent to ASU)

Combined species list for all wilderness areas:

Included with this report is a listing of all the lichen species from all seven Class I wilderness areas included in this project. This table includes current species names, general distribution information by wilderness and relative abundance information for each species. A total of 291 species in 82 genera were collected from all wilderness areas during the course of this project. Due to the fact that each wilderness area is somewhat unique in terms of substrates, microhabitats and physical factors, comparisons between wilderness areas based on absolute species numbers, or even relative abundance of selected species are probably invalid. Furthermore, there is some variance in the actual collecting time between wilderness areas. These species lists are preliminary and depending on the wilderness area, actually represent between 50 and 80% of the total lichen flora. Depending on the wilderness area somewhere between 7 and 12 days of additional collecting will be necessary to bring the list to between 90 and 100% completion.

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Acarospora							
cervina var.							
glauccarpa				R	R-LC		
chlorophana	R-C	R-LC	LC				C
cinereoalba		R		LC	R-LC		
fuscata		C		C			LC
oligospora		R					
oxytona		LC	LC	LC			
peltastica		R					
scheicheri	R-C	LC					
strigata		C		LC		R	
sp. 1	R	R-C		R			R-LC
sp. 2	R	R					
sp. 3		R-LC					
sp. 4		R					
sp. 5		LA					
Anaptychia							
palmaria		C-A	LC			R-C	
Aspicilia							
alphoplaca	R-LC	R-LC	R-LC	LC	LC	R	R
caesiocinerea	R-C		R				
calcarea		C	LC	LC	LC	R-LC	C
cinerea	C	C	C		R-LC	LC	C-A
contorta							R

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Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Aspicilia (cont.)							
desertorum				R	LC		
radiosa		LC					
quartzitica	C		R-LC		R-LC		
sp. 1		R					
Bellemerea							
cinereorufescens				R-LC		R-LC	
Biatora							
botryosa				R			
Bryoria							
furcellata						A	
simplicior						R	
Buellia							
erubescens	R		R	.	R-LC		
lacteoidea						R-LC	
lepidastraea		R		R-LC			
mamillana		R					
puntata	R	R	R	R	R-LC	LC	
retrovertens				R			
semitensis						R-LC	R
spuria							R
triphragmioides		R-LC					
turgescens	R					R-LC	
sp. 1						R	

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Caloplaca							
arizonica		LC	C		LC-C	R-LC	
cerina	R	LC	R			R-LC	LC
chrysophthalma	R-C	LC	LC	R-LC	LC		
cinnabarina		C	C	R	LC		
discolor		C	LC			R-LC	
durietzii	C	R-C			LC		
epithallina			R			R	
exsecuta							
flavovirescens	C		C	LC	LC	LC	R
fraudans	R						
holocarpa	R-C	LC				R	LC
microphyllina						LC	
modesta				C		R-LC	LC
pelodella		R		C	LC		
saxicola		R				R	R
sideritis	R		R				
Candelaria							
concolor var.							
effusa				LC	R	R	LC
Candelariella							
aurella	C	C					
deflexa	R-C	R	R	R			
rosulans	C	R-LC	LC	R-LC		LC	

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Candelariella (cont.)							
<i>submexicana</i>	R			LC			
<i>vitellina</i>		R-C	LC				
<i>xanthostigma</i>					R		
Candelina							
<i>submexicana</i>						LC	
Carbonea							
<i>vorticosa</i>	R	R					
Catapyrenium							
<i>lachneum</i>	C	LC-A		LC	LC	R	
Cetraria							
<i>coralligera</i>			LC				
<i>weberi</i>		LC					R
Chaenotheca							
<i>furfuracea</i>			R				
Cladonia							
<i>bacillaris</i>					R		
<i>crinitosa</i>		R					LC
<i>chlorophaea</i>		LC					LC
<i>coniocraea</i>			LC				
<i>fimbriata</i>					LC		
<i>pyxidata</i>	LC	LC	R	LC			LC

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Collema							
<i>coccophorum</i>		R				R	
<i>furfuraceum</i>		R	R		LC	R	
<i>fuscovirens</i>				R	R-LC	R-LC	
<i>polycarpon</i>	R-C			LC	LC		
<i>subflaccidum</i>		LA					
<i>tenax</i>		LC				R-LC	
<i>texanum</i>	R						
<i>undulatum</i>		R					
Cyphelium							
<i>tigillare</i>		R-LC	R			R	
Dermatocarpon							
<i>intestiniforme</i>					C	LC	
<i>miniatum</i>	LC	LC-A	LA		C	LC	
<i>moulinsii</i>			R			R	
<i>reticulatum</i>	LC-A	R-C	LA	LC	LC	LC	
Dimelaena							
<i>oreina</i>	C	R	LC			LC	
Diploschistes							
<i>diacapsis</i>					LC		
<i>muscorum</i>	R				R		
<i>scruposus</i>	R-C	R-C	LC		R	R	

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Diplotomma alboatum				LC			
Endocarpon pulvinatum	R						
pusillum	R-C	LC		R			
wilmsoides	R				R		
Flavoparmelia caperata							LC
Flavopuntelia darrovi	R-LC		LC				R-LC
flaventior	R-C	R-LC			LC	R-LC	C
praesignis	R						LC
soredica	C-A	C	LA	R	LC	R-C	R-LC
Heppia lutosa	R						
Heterodermia hypoleuca							LC
rugulosa			R				R
speciosa							
Hyperphyscia adglutinata				LC	LC		
Hypocenomyce castaneocinerea							LC
friesii							LC

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Hypocenomyce (cont.)							
scalaris			R				LC
xanthococca			R				
Hypogymnia							LC
physodes							LC
Hypotrachyna							
pulvinata							C-A
Imshaugia							
aleurites							R-LC
placorodia		LC				R-LC	LC-A
Lasallia							
papulosa	LC						
Lecanora							
argopholis				R			
argentata	R		LC		R-LC	R	R-LC
caesiorubella			R				
subsp. saximontana							R
carpinea							R-LC
cenisia		R		R			
christoi	R			R-LC			
crenulata						R-LC	
dispersa	R						
garovagliai	R			R-LC			
impudens	R		R-LC				R-LC

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lecanora (cont.)							
muralis	C	C	LC	C	LC	LC	
novomexicana	C		LC	R			
piniperda						R	R
polytropa	R						R
rugosella						LC	
rupicola							LC
saligna	R	R	R				R
sierrae		R				R	R
symmicta						R	
thallophila				R	R	R	
valesiacaca					R	R	
varia		R-LC				R	R
Lecidea							
atrobrunnea		R-LC	LC				R
auriculata		R-LC		R-LC			
botryosa	R						
elabens						R	
tessellata	C	C			LC	LC	LC
tornoensis							LC
turgidula		R-LC				LC	R
sp. 1		R					

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lecidella							
carpathica		R			R-LC	C	
euphorea		R-LC				LC	LC
stigmataea		R		R-LC		LC	
viridans		LC					R
Lepraria							
finkii		R					R
Leprocaulon							
albicans	LC		R-LC				LC
Leproloma							
membranaceum			LC-A			R	
Leptogium							
arsenei					R	LC	LC
cyanescens	LC	R-LC	C		LC	LC	LC
denticulatum	LC		LC			LC	R-LC
furfuraceum		LC	LC		LC	LC	R
hirsutum			R				
lichenoides	R		R		LC		
saturninum		R				R-LC	
sp.	R-LC						
Letharia							
vulpina		R					

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lichenothelia							
scopularia							R
Megaspora							
verrucosa	R		LC				
Melanelia							
exasperata	R-C			R			
halei						R	
incolorata	R-C						
olivacea						R	
olivaceoides					R		
subargentifera	LC	C	R				
subolivacea			R		R-LC		R-LC
substygia			LC				R
Mycocalicium							
subtile	R		R				R-LC
Neofuscelia							
infrapallida	R-C	R	LC	R-LC	R-LC	C	
Ochrolechia							
androgyna		R	R			R	R
pallescens		LA	LC				LC
Pannaria							
leucophaea	R		R		R-LC	R	R
tavaresii							R

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
<i>Parmelia</i> <i>sulcata</i>							R
<i>Parmeliopsis</i> <i>ambigua</i>		LC					LC
<i>Parmotrema</i> <i>hababianum</i>	LC		R-LC		LC	LC	
<i>Peccania</i> <i>arizonica</i>	R	R		R			
<i>Peltigera</i> <i>canina</i>	LC	LC			LC		LC
<i>collina</i>		R					
<i>malacea</i>		LC					R-LC
<i>membranacea</i>			LC		R-LC		
<i>Peltula</i> <i>euploca</i>				R			
<i>Pertusaria</i> <i>albescens</i>							R
<i>amara</i>			LC				R
<i>arizonica</i>							R
<i>saximontana</i>		LC	LC		LC	R-LC	
<i>sommerfeltii</i>							R
<i>wulfenioides</i>							C-A

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Phaeophyscia							
<i>cernohorskii</i>	R				LC	LC	
<i>ciliata</i>	R	R					LC
<i>hispidula</i>							LC
<i>orbicularis</i>	R		R				R-LC
<i>sciastra</i>	R	R	R				
Physcia							
<i>aipolia</i>	R		LC		R-LC	LC	
<i>alba</i>		R					
<i>albinea</i>	R					R-LC	R
<i>caesia</i>	R		R	R	R	R-LC	LA
<i>callosa</i>	R						R-LC
<i>crispa</i>	R						LC
<i>dubia</i>		R-LC	LC-A	R .	R-LC		
<i>halei</i>						R	R-LC
<i>phaea</i>			R				
<i>stellaris</i>	LC	C	LA	R-LC	R-LC	LC	R-LC
<i>subtilis</i>		R	R				LC
Physconia							
<i>detersa</i>	R				R-LC	R	
<i>enteroxantha</i>	R		LC-A		R-LC	R	
<i>grisea</i>		R	LC-A				
<i>perisidiosa</i>		R	R		R		

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Placynthium <i>nigrum</i>				R			
Polychidium <i>muscicola</i>	R						
<i>sp. 1</i>	R						
Pseudevernia <i>intensa</i>							C-A
Psora <i>decipiens</i>		LC-A			LC		
<i>himalayana</i>					R		
<i>icterica</i>	C-A			R-LC			
<i>luridella</i>					R	R	
<i>nipponica</i>	R		LC		R		R-LC
<i>pseudorussellii</i>		R			LC		
<i>tuckermanii</i>							
Punctelia <i>hypoleucites</i>	LC	LC	LC		R-LC		LC
<i>subrudecta</i>			R				R
Ramalina <i>americana</i>				R-LC			
<i>pollinaria</i>				LC-A			LC
<i>sinensis</i>		R	LC				R

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Rhizocarpon							
disporum	C	LC	C	LC	LC R	C	LC
geographicum							
intermediellum	R		R				
Rhizoplaca							
chysoleuca	LC	R-LC	LC			R-LC	
melanophthalma		LC	R-LC				R
Rinodina							
archaea	R						
bischoffii		R					
confragosa			R				
exigua		R				R	R
milvina		R					
pachysperma		C			R-LC	R	
pyrina							LC
Sarcogyne							
regularis		R					
sp.	R						
Scoliosporum							
umbrinum			R				
Squamaria							
degelii		R		R			

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Staurothele							
<i>catalepta</i>		R		C		LC	LC
<i>fuscocuprea</i>	R-C						
<i>rufa</i>		R					
Tephromela							
<i>atra</i>		LC	LC				R
Thelidium					R		
<i>pyrenophorum</i>							
Thyrea					LC		
<i>pulvinata</i>							
Toninia							
<i>caeruleonigricans</i>		LC					
<i>tristis</i>		LC					
Trapeliopsis							
<i>granulosa</i>		R					R
Tuckermannopsis							
<i>fendleri</i>		LC					C
<i>pinastri</i>							LC
Umbilicaria							
<i>hirsuta</i>							R
<i>phaea</i>			R				
<i>torrefacta</i>		LC	LC-A				
<i>vellea</i>			LC-A				

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
 Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Usnea							
arizonica							C
cavernosa							C
herrei							R
hirta		R-A	LC		R-LC	LC	R-LC
subfloridana							R-C
Verrucaria							
lecidoides	R						
muralis		LC					
nigrescens							R
viridula		R		R			
Xanthoparmelia							
barbatica				R			
coloradoensis		C	LC	R-LC	LC	C	LC
conspersa	LC	LC					
cumberlandia	C	C		C	LC		R-LC
lineola	R-C	R	LC	LC			
monticola		R					
neoconspersa		R-LC					R-LC
neotaractica							
nigropssoromifera	R-C						
novomexicana	R					R	R
planilobata							
plittii	C	R-LC		C			

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Xanthoparmelia (cont.)							
<i>psoromifera</i>	LC	C					R
<i>somloensis</i>	R	LC					
<i>subramigera</i>				C	LC		
<i>weberi</i>				R			
<i>wyomingica</i>	C						
sp. 1		C					
sp. 2		R					
Xanthoria							
<i>elegans</i>		R			LC	R-LC	LC
<i>fallax</i>	LC	LC	LC	LC	R-LC	R-LC	
<i>polycarpa</i>		R-LC	LC				R-LC
<i>sorediata</i>		LC				LC	

AIR POLLUTION SENSITIVE LICHEN SPECIES
(Material collected for elemental analyses)

TABLE 2: List of air pollution sensitive lichen species collected from Mazatzal Wilderness Area, Arizona. Growth form, substrate and site information is given for each species.

GENUS/SPECIES	GROWTH FORM	SUBSTRATE	COLLECTION SITE(S)
Dermatocarpon miniatum	foliose	rock	Hardscrabble Canyon
Usnea hirta	fruticose	bark	Hardscrabble Canyon
Xanthoparmelia coloradoensis	foliose	rock	Sheep Bridge Trail, Barnhardt Trail
cumberlandia	foliose	rock	Sheep Bridge Trail
Xanthoria fallax	foliose	bark	Sheep Bridge Trail

Table 3: Elemental analysis data for selected species of lichens from reference sites in the Mazatzal Wilderness Area, September 1990.

Species Sites (substrate)	Pb (ppm)	Cu (ppm)	S (%)
<i>Usnea</i> <i>hirta</i>	41 (34-48)	15.4 (14-18)	.19 (.18-.21)
<i>Xanthoparmelia</i> <i>cumberlandia</i>	43 (40-45)	57.5 (52-66)	.227 (.18-.28)

BIBLIOGRAPHY

- Egan, Robert S. 1987. A Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada. THE BRYOLOGIST 90(2).
- Egan, Robert S. 1989. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada." Edition I. THE BRYOLOGIST 92(1): 68-72.
- Egan, Robert S. 1990. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada." Edition II. THE BRYOLOGIST 93(2): 211-219.
- Fields, R. D. and L. L. St. Clair. 1984. A comparison of methods for evaluation SO₂ impact on selected lichen species: *Parmelia cholorchra*, *Collema polycarpon* and *Lecanora muralis*. THE BRYOLOGIST 87: 297-301.
- Fields, R. D. and L. L. St. Clair. 1984. The effects of SO₂ on photosynthesis and carbohydrate transfer in the two lichens: *Collema polycarpon*, *Parmelia chlorochroa*. American Journal of Botany 71: 986-998.
- Gough, L. P. and J. A. Erdman. 1977. Influence of a coal-fired power plant of the element content of *Parmelia chlorochroa*. THE BRYOLOGIST 80: 492-501.
- Hale, M. E. 1983. The Biology of Lichens, pp. 1-190. Arnold Publishers, London.
- Lawrey, J. D. and Hale, M. E. 1981. Retrospective study of lichen lead accumulation in the northeastern United States. THE BRYOLOGIST 84: 449-56.
- Richardson, D. H. S., and E. Nieboer. 1981. Lichens and pollution monitoring. Endeavour, new Series 5 (3): 127-133.
- Rope, S. K. and L. C. Pearson. 1990. Lichens as Air Pollution Biomonitorors in a Semiarid Environment in Idaho. THE BRYOLOGIST 93 (1): 50-61.
- Rushforth, S. R., L. L. St. Clair, J. D. Brotherson, and G. T. Nebeker. 1989. Lichen Community Structure in Zion National Park. THE BRYOLOGIST 85(2): 185-192.
- St. Clair, L. L. 1989. Report concerning Establishment of a Lichen Biomonitoring Program for the Jarbidge Wilderness Area, Humboldt National Forest, Nevada. U. S. Forest Service Technical Report
- Schutte, J. A. 1977. Chromium in two corticolous lichens from Ohio and West Virginia. THE BRYOLOGIST 80: 279-283.

- Skye, E. 1979. Lichens as biological indicators of air pollution. Annual Review of Phytopathology 17: 325-341.
- Sundstrom, K. R., and J. E. Hallgren. 1973. Using lichens as physiological indicators of sulfurous pollutants. AMBIO 2: 13-21.
- Wetmore, C. M. 1981. Lichens and air quality in Big Bend National Park, Texas. THE BRYOLOGIST 84: 426-433.
- Wetmore, Clifford M. 1987. Lichens and Air Quality in Saguaro National Monument. Technical report submitted to the US National Park Service, CX 0001-2-0034.
- Wetmore, C. M. 1989. Lichens and air quality in Cuyahoga National Recreation Area, Ohio. THE BRYOLOGIST 92(3): 273-281.